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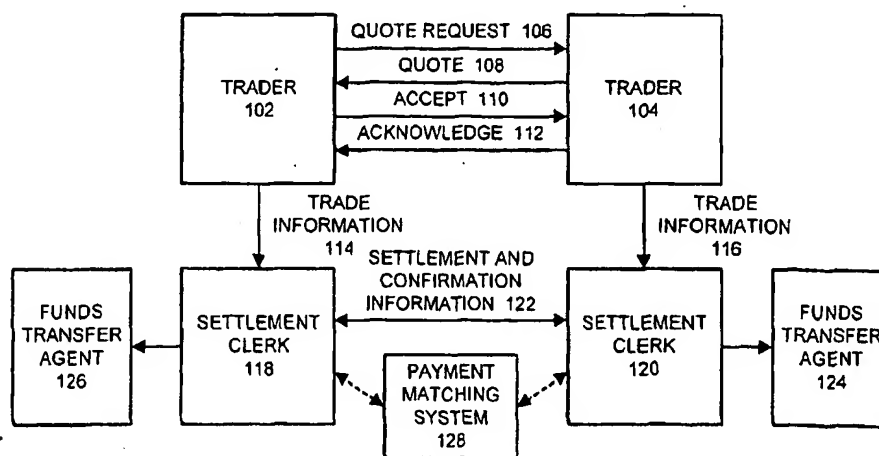
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(54) Title: USING DIGITAL SIGNATURES TO STREAMLINE THE PROCESS OF AMENDING FINANCIAL TRANSACTIONS



(57) Abstract: One embodiment of the present invention provides a system that uses digital signatures to validate an amendment to a financial transaction, wherein the financial transaction was previously agreed upon between a first party and a second party. The system operates by receiving a request to make the amendment from a first representative of the first party, wherein the request includes a suggested change to at least one term of the financial transaction. Next, the system validates that the first representative of the first party digitally signed the request by using a public key of the first representative to verify that the request was signed by a corresponding private key belonging to the first representative. If this validation establishes that the first representative signed the request, and if the second party desires to agree to the request, the system allows a second representative of the second party to confirm the request by digitally signing the request with a private key belonging to the second representative. The system subsequently returns the confirmed request to the first party.

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# USING DIGITAL SIGNATURES TO STREAMLINE THE PROCESS OF AMENDING FINANCIAL TRANSACTIONS

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## BACKGROUND

### Field of the Invention

The present invention relates to computer-based systems for trading financial  
15 instruments. More specifically, the present invention relates to a method and an  
apparatus that uses digital signatures to validate the process of amending trading  
and/or settlement instructions for a financial transaction, such as a foreign exchange  
transaction.

### Related Art

The foreign exchange market is the largest and most liquid market in the  
world. In 1998, the Federal Reserve Bank of New York estimated, that daily turnover  
was approximately \$1.5 trillion.

Unlike stocks, which are market-traded, foreign exchange is primarily an  
25 over-the-counter market. There is no such thing as a "price" for a particular  
transaction. Rather, each dealer, bank, broker, or other trading source, provides their  
own rate for each transaction.

The trading and settlement processes for a typical foreign exchange  
transaction are illustrated in FIG. 1. A trader 102, working on behalf of a corporation  
30 or other entity, makes a quote request 106 to a trader 104, working on behalf of a

bank. In response to this quote request, trader 104 makes a quote 108 proposing a rate for the transaction.

Trader 102 accepts the quote by sending an acceptance message to trader 104, in which case trader 104 typically sends an acknowledgement message 112 back to  
5 trader 102.

Note that the communication process outlined above typically takes place over the telephone or via facsimile.

After traders 102 and 104 agree to the terms of the transaction, trader 102 communicates trade information to settlement clerk 118, who works on behalf of the  
10 same organization as trader 102. Similarly, trader 104 communicates trade information 116 to settlement clerk 120, who works on behalf of the same organization as trader 104.

Settlement clerks 118 and 120 are responsible for actually causing funds to be transferred between accounts of the two organizations involved in the trade. Before  
15 doing so, settlement clerks 118 and 120 communicate and confirm settlement information 122 with each other. This settlement information 122 confirms the terms of the trade, and additionally specifies the accounts between which funds are to be transferred.

Note that settlement clerks 118 and 120 typically communicate settlement  
20 information 122 via telephone or facsimile. In some cases, this settlement information is communicated through a third party payment matching system 128.

After the settlement information is communicated, and if the terms of the deal are in agreement, settlement clerk 118 communicates with funds transfer agent 126, who actually transfers the funds. Similarly, settlement clerk 120 communicates with  
25 funds transfer agent 124 to transfer funds in the reverse direction.

Note that the separation of roles between trading and settlement provides a measure of protection against fraud because collusion between a trader and a settlement clerk is required to perpetrate most types of fraud. However, this protection has a price, because the many manual communications, validations, and

confirmations involved in the role-based trading and settlement processes are time-consuming and expensive.

Also note that the trade terms and settlement instructions are typically entered manually on both sides of the transaction. Consequently, the trade terms and settlement instructions are often not entered in the same way, and may not match. Even if the trade terms and settlement instructions are entered properly, netting and aggregation can cause trades not to match. If trades do not match, a great amount of additional work is required to sort out inconsistencies.

What is needed is a method and an apparatus for facilitating trading and settlement of financial instruments, such as currencies, without the time-consuming manual processes involved in existing trading, settlement, and confirmation processes.

An additional challenge arises when a trade that has been agreed upon between two parties is later amended by the parties. For example, a first party to a foreign exchange transaction may desire to change the value date of a transaction from one month to three months. In exchange for this change, the second party may agree to adjust the exchange rate.

Such trade amendments are presently processed manually. This manual processing typically starts with a telephone call or a facsimile communication requesting the trade amendment. After the amended terms are agreed to, the amendment terms are typically entered manually on both sides of the transaction, with all of the same problems and inefficiencies associated with entering details of the original trade.

Hence, what is needed is a method and an apparatus for facilitating the amendment of a previously agreed upon financial transaction, without time-consuming manual processing operations.

### SUMMARY

One embodiment of the present invention provides a system that uses digital signatures to validate an amendment to a financial transaction, wherein the financial transaction was previously agreed upon between a first party and a second party. The

system operates by receiving a request to make the amendment from a first representative of the first party, wherein the request includes a suggested change to at least one term of the financial transaction. Next, the system validates that the first representative of the first party digitally signed the request by using a public key of the first representative to verify that the request was signed by a corresponding private key belonging to the first representative. If this validation establishes that the first representative signed the request, and if the second party desires to agree to the request, the system allows a second representative of the second party to confirm the request by digitally signing the request with a private key belonging to the second representative. The system subsequently returns the confirmed request to the first party.

In one embodiment of the present invention, prior to confirming request, the system additionally validates that the first representative has permission to agree to the amendment by verifying that permission information for the first representative is digitally signed by a trusted entity.

In one embodiment of the present invention, if the validation establishes that the first representative signed the request, and if the second party does not agree to the request, but instead desires to propose counter-terms, the system allows the second party to propose counter-terms. This is accomplished by first creating a responding request including a responding amendment with the counter-terms. Next, the system allows the second representative of the second party to digitally sign the responding request with a private key belonging to the second representative. The system then sends the signed responding request to the first party.

In one embodiment of the present invention, the system validates that the second representative of the second party digitally signed the responding request by using a public key of the second representative to verify that the responding request was signed by a corresponding private key belonging to the second representative. If this validation establishes that the second representative signed the responding request, and if the first party desires to agree to the responding request, the system allows the first representative of the first party to confirm the responding request by

digitally signing the responding request with a private key belonging to the first representative. The system then returns the confirmed responding request to the second party.

5 In one embodiment of the present invention, prior to allowing the first representative to confirm the responding request, the system validates that the second representative has permission to agree to the amendment by verifying that permission information for the second representative is digitally signed by a trusted entity.

In one embodiment of the present invention, the system records the request and any response to the request in a database.

10 In one embodiment of the present invention, the system validates an identity of the first party by using a public key of a certification authority to verify that a certificate containing the public key of the first party was signed by a corresponding private key belonging to the certification authority. Note that the signing by the certification authority indicates that the certification authority has verified the identity  
15 of the first party.

In one embodiment of the present invention, the system receives the request from the first party through a trade facilitator. Furthermore, the confirmed request is returned to the first party by forwarding the confirmed request through the trade facilitator.

20 In one embodiment of the present invention, prior to receiving the request to make the amendment, the system allows the first representative of the first party to obtain permission to agree to the amendment. The system accomplishes this by sending a request for permission to a first security officer associated with the first party. Next, the system allows the first security officer to digitally sign a permission  
25 record to indicate the first representative has permission to agree to the amendment.

In one embodiment of the present invention, the financial transaction involves foreign exchange, and a trade record for the financial transaction includes: a trade date, an identifier for a first currency, a first currency amount, an identifier for a first organization providing the first currency, an identifier for a second currency, a second

currency amount, and an identifier for a second organization providing the second currency.

### BRIEF DESCRIPTION OF THE FIGURES

5       FIG. 1 illustrates typical trading and settlement processes.

FIG. 2 illustrates an exchange that facilitates automated trading and settlement in accordance with an embodiment of the present invention.

FIG. 3 illustrates how credentials and permissions are granted in accordance with an embodiment of the present invention.

10       FIG. 4 is a flow chart illustrating the process of obtaining a credential from a certification authority in accordance with an embodiment of the present invention.

FIG. 5A is a flow chart illustrating how an exchange security officer is authorized in accordance with an embodiment of the present invention.

15       FIG. 5B is a flow chart illustrating how a security officer obtains authority to grant permissions in accordance with an embodiment of the present invention.

FIG. 6 is a flow chart illustrating the process of obtaining a permission from a security officer in accordance with an embodiment of the present invention.

FIG. 7 is a flow chart illustrating the process of facilitating a trade in accordance with an embodiment of the present invention.

20       FIG. 8 is a flow chart illustrating the process of settling a trade in accordance with an embodiment of the present invention.

FIG. 9 illustrates the structure of a trade record in accordance with an embodiment of the present invention.

25       FIG. 10 is a flow chart illustrating the process of establishing a policy for a trade and/or amendment approvals in accordance with an embodiment of the present invention.

FIG. 11 illustrates the structure of an amendment record in accordance with an embodiment of the present invention.

30       FIG. 12 is a flow chart illustrating the process of amending a trade in accordance with an embodiment of the present invention.



### DETAILED DESCRIPTION

The following description is presented to enable any person skilled in the art to make and use the invention, and is provided in the context of a particular application and its requirements. Various modifications to the disclosed embodiments will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the present invention. Thus, the present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

The data structures and code described in this detailed description are typically stored on a computer readable storage medium, which may be any device or medium that can store code and/or data for use by a computer system. This includes, but is not limited to, magnetic and optical storage devices such as disk drives, magnetic tape, CDs (compact discs) and DVDs (digital versatile discs or digital video discs), and computer instruction signals embodied in a transmission medium (with or without a carrier wave upon which the signals are modulated). For example, the transmission medium may include a communications network, such as the Internet.

#### Exchange System

FIG. 2 illustrates an exchange 200 that facilitates automated trading and settlement in accordance with an embodiment of the present invention. Exchange 200 facilitates trades between treasury systems 202-204 and trading systems 208-210. Exchange 200 can additionally be coupled to a number of other exchanges 206-207. Note that exchange 200, treasury systems 202-204 and trading systems 208-210 run on computer systems. These computer systems can generally include any type of computer system, including, but not limited to, a computer system based on a microprocessor, a mainframe computer, a digital signal processor, a portable computing device, a personal organizer, a device controller, and a computational engine within an appliance.

Also note that linkages shown in FIG. 2 pass across one or more computer networks (not shown). These networks generally include any type of wire or wireless communication channel capable of coupling together computing nodes. This includes, but is not limited to, a local area network, a wide area network, or a combination of networks. In one embodiment of the present invention, the network includes the Internet.

Treasury systems 202-204 generally belong to organizations requiring foreign exchange services, such as corporations, funds or non-governmental organizations (NGOs) but could also include banks requesting trades. Hence, treasury systems 202-204 generally request quotes for from trading systems 208-210, and accept quotes from trading systems 208-210.

Trading systems 208-210 generally belong to banks providing foreign exchange services but could include other organizations that choose to act as quote makers. Hence, trading systems 208-210 generally receive quote requests from treasury systems 202-204, and make quotes to be accepted by treasury systems 202-204.

Treasury systems 202-204 are coupled to one or more funds transfer agents, such as funds transfer agent 220, which carry out instructions to actually transfer funds between accounts. Similarly, trading systems 208-210 are coupled to one or more funds transfer agents, such as funds transfer agent 221. Note that funds transfer agents 220 and 221 may be the same funds transfer agent.

Exchange 200 communicates secure, authenticated quote requests, quotes and quote acceptances between treasury systems 202-204 and trading systems 208-210. Exchange 200 also facilitates communication of settlement instructions between treasury systems 202-204 and trading systems 208-210. These functions are described in more detail with reference to FIGs. 3-9 below.

Note that exchange 200 can additionally be coupled to exchanges 206-207 to facilitate cross-exchange transactions.

**Relationships Between Actors and Organizations**

5           FIG. 3 illustrates the relationships and interactions of the involved actors and organizations in accordance with an embodiment of the present invention. In FIG. 3, organization 302 trades with organization 304 through exchange 200. Certification authority 320 can include any independent entity, such as an accounting firm or an independent certification authority, that verifies the identity of users and grants  
10   credentials for use by various actors belonging to organizations 302-304 and to exchange organization 306.

          More specifically, organization 302 includes treasury system 202, which communicates with exchange 200. Treasury system 202 operates under control of user 310, such as a front office trader, who receives permissions from a local security  
15   officer 312, who also is associated with organization 302. Organization 302 also includes a settlement clerk 311, who is responsible for settling trades made by user 310.

          Similarly, organization 304 includes trading system 208, which communicates with exchange 200. Trading system 208 operates under control of user 318, who  
20   receives permissions from a local security officer 316, who is also associated with organization 304. Organization 304 also includes a settlement clerk 319, who is responsible for settling trades made by user 318.

          Exchange organization 306 includes exchange 200 as well as permission security officer 314, who confers permission granting authority to local security  
25   officers 312 and 316 in conjunction with CA 320 through the process outlined in FIG. 5 below. Note that exchange 200 is coupled to a database 301, which contains permission table 305. Permission table 305 contains permissions for users 310 and 318, security officers 312 and 316, and settlement clerks 311 and 319.

          All of the above-described entities receive credentials from independent  
30   certification authority (CA) 320, which grants credentials to users 310 and 318, security officers 312, 314 and 316, and settlement clerks 311 and 319. This credential granting process is described below with reference to FIG. 4.

During operation of the system illustrated in FIG. 3, CA 320 generates credentials 330-334 that are used by actors, such users 310 and 318, security officers 312, 314 and 316 and settlement clerks 311 and 319 to validate identities.

In addition to validating identities, the system illustrated in FIG. 3 validates permissions to perform operations, such as trading and settling trades, and can embed information into the trading records so that these validations can be performed independently by organizations 302 and 304. Permission security officer 314, who belongs to exchange organization 306, confers permission granting authority on security officers 312 and 316 belonging to organizations 302 and 304, respectively. Security officers 312 and 316 in turn grant trading permissions 340 and 341 to users 310 and 318, respectively. Security officers 312 and 316 can also grant settlement permissions 342 and 343 to settlement clerks 311 and 319, respectively. Note that users 310 and 318 require both permissions and credentials in order to perform actions, such as trading and settling trades.

Note that in the present invention, permissions for various actors are stored within a central permission table 305, instead of being embedded within certificate chains in credentials of the actors. Table 305 correlates permission additions, subtractions and modifications to provide an up to date unified view of all user authorizations in the system. Table 305 stores the signed permission request records that can be used to determine the entity (security officer) that granted the particular permission to the individual. When a user's authorizations are queried, permission table 305 returns a signed response containing the collection of signed permission requests associated with the user along with a timestamp value to validate the user's permissions at the time of the query. Since permission queries can be performed concurrently with permission updates, the system defines a minimum quiescent period (typically < 10 seconds) which delays the recognition of permission changes to allow queries to complete in a consistent state.

Also note that in one embodiment of the present invention, there exist multiple security officers for organization 302, organization 304 and exchange organization 306. In this embodiment, more than one security officer must agree in order to

change the privileges of a security officer. This prevents a single security officer from unilaterally changing his or her own privileges. The organization 302 or 304 may also specify that more than one security officer is required to agree to authorize permissions of other users as well.

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#### **Process of Bootstrapping Exchange Security Officers**

In order to bootstrap the system, exchange organization 306 must first initiate the creation of at least two exchange security officers: a Credential Security Officer (CSO) 315 and a Permission Security Officer (PSO) 314. These two security officers  
10 must be independent individuals in order to enforce a separation of duties. Exchange organization 306 communicates a schedule to CA 320 identifying these security officers within exchange organization 306. The two security officers CSO 315 and PSO 314 may then request and receive credentials 332 from CA 320 following the procedure outlined in FIG. 4.

15 Once the credentials are granted, exchange organization 306 must then initiate the creation of permissions for the two security officers. Note that it is desirable that "credential creation" and "permission creation" permissions be mutually exclusive to maintain separation of duties. Ideally, no single actor in the system should be granted both "credential creation" and "permission creation" permission as a safeguard for  
20 fraud. Exchange organization 306 communicates a schedule to CA 320 granting the following permissions to the respective security officers:

##### **Credential Security Officer (CSO)**

- CSO credential creation permission
- 25 • PSO credential creation permission

##### **Permission Security Officer (PSO)**

- CSO permission creation permission
- 30 • PSO permission creation permission

Once the two initial security officers are successfully bootstrapped with the appropriate credentials and permissions, additional exchange CSOs and PSOs can be added into the system. The original CSO 315 can first create and approve a new

CSO. The original PSO 314 may then confer CSO permissions upon the new CSO. At that point, the newly created CSO is functionally identical to the bootstrapped CSO. Similarly an additional PSO may be created within the system. Exchange organization 305 may wish to establish more restrictive guidelines concerning the creation of CSOs and PSOs requiring the approval to multiple CSOs or PSOs respectively. In such instances, the bootstrap process must be augmented by the appropriate number of security officers to ensure the guidelines are met.

#### **Process of Bootstrapping Member Organization Security Officers**

Independent organizations that may wish to join the system can request the appropriate credentials and permissions for their own CSO and PSO representatives who then have the authorization to grant credentials and permissions for users within their own organization. Member organization 302 communicates a schedule to a CSO in exchange organization 306 identifying these designated security officers within member organization 302. Once these credentials are requested and received, the member organization can communicate a schedule of permissions for a PSO in exchange organization 306 granting the following permissions:

##### **Credential Security Officer (CSO)**

- CSO credential creation permission
- PSO credential creation permission
- User credential creation permission

##### **Permission Security Officer (PSO)**

- CSO permission creation permission
- PSO permission creation permission
- Trading permission creation permission
- Settlement permission creation permission

Additional permissions may be defined as required. Certain permissions such as the trading permission and settlement permission should ideally be identified as mutually exclusive in order to eliminate the possibility of a single actor committing fraud within the system.

Once the two initial security officers are successfully bootstrapped with the

appropriate credentials and permissions, additional organization CSOs and PSOs can be added into the system as well as organization users that will be conducting trades and settlements. This distributed mechanism allows the member organizations to independently manage their authentication and authorization functions according to their internal policies and procedures.

#### **Process of Obtaining a Credential**

FIG. 4 is a flow chart illustrating the process of obtaining a credential 330 for a user 310 in accordance with an embodiment of the present invention. Note that in one embodiment of the invention, this credential is implemented as a digital certificate. The process starts when user 310 requests a credential 330 from an organization CSO. In response to the request, CSO instructs user 310 to contact CA 320 (step 404). The organizational CSO additionally instructs CA 320 to issue a credential for user 310 (step 406).

Next, user 310 constructs a public key/private key pair (step 408) through their browser or a hardware cryptographic token, and then sends the newly created public key along with a request for a credential to CA 320 (step 410).

CA 320 then verifies the authenticity of the request (step 412). This process involves determining if a CSO has instructed CA 320 to issue the credential 330. It also involves performing some type of manual or automated identity check on user 310. For example, the check can involve a database lookup of information on user 310, an interview with user 310, a telephone call to user 310 or a facsimile communication with user 310. In one embodiment, a unique randomly generated personal identification number (PIN) is communicated by the CSO to both user 310 and CA 320 that identifies to CA 320 this request for a credential is valid. This PIN can only be used once to request signing of the credential by CA 320. The user's corresponding PSO will authenticate requests for permission by signing permissions in the permission table 305 (see below).

If the request is properly verified, CA 320 signs credential 330 with a private key belonging to CA 320 (step 414), and returns credential 330 to user 310 and to CX

200 (step 416). CX 200 then places the new credential 330 for user 310 in its database 301 (step 418). Note that credential 330 is signed by CA 320 and includes a public key for user 310.

## 5 **Process of Validating a Credential**

Throughout the trade creation, amendment and settlement process, the actors in the system including users 310 and 318, security officers 312, 314 and 316, and settlement clerks 311 and 319 may require validation of the credentials of fellow actors with whom they are interacting within the system. In one embodiment of the invention, the permission table 305 acts as the system of record for credential validity. The status of credentials 330-334 may be confirmed as valid by querying the permission table. If the credential presented for validation matches a credential stored in permission table 305, the system returns a signed response containing a timestamped credential record that confirms the validity of the credential. If the credential is not found in permission table 305, the system returns a signed, timestamped response that indicates that the queried credential was not valid. In one embodiment of the invention, actors may query the validity of a credential by checking if the digital certificate is listed with a revoked status in a Certificate Revocation List (CRL) published by certification authority 320. An alternate method would be to send an Online Certificate Status Protocol request (OCSP) to certification authority 320 to query the real-time status of the digital certificate.

If a credential does not successfully verify, ideally the actor should not be permitted to continue their participation within the system and their requested action should be blocked from further execution.

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## **Process of Obtaining a Permission**

FIG. 6 is a flow chart illustrating the process of obtaining a permission 340 from a organization PSO for a user 310 in accordance with an embodiment of the present invention. User 310 first sends a request to a PSO to obtain a permission, such as the permission to trade (step 602). The request contains information

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including the user's credential and a unique string that identifies the permission that the user is requesting and is signed by the user's private key. The PSO then validates the identity of user 310 by retrieving the public key for user 310 from the permission table 305 and using the public key to validate the signature of the request. If the  
5 identity validates, the PSO determines whether to grant the permission based upon authorization rules and processes defined by organization 302 (step 606). If the permission is to be granted, the PSO signs the request with a private key belonging to the PSO. The system performs an internal query of permission table 305 to verify that the PSO has the appropriate permission to grant permissions to user 310 and if the  
10 query is successful, the request is stored within permission table 305 (step 608). Steps 604 through 608 are then repeated for each signature required by the authorization policy of the organization 302. Note that for some users, such as security officers, organizations may establish policies that may require signatures from multiple security officers in order to add/modify/remove their permission records. This  
15 prevents a single security officer from unilaterally authorizing powers for himself. Also note that requiring multiple signatures generally increases the security of the system because multiple actors are required to collude in order to improperly authorize additional powers for a user.

The PSO then sends an acknowledgement to user 310 to complete the process  
20 (step 610).

If the permission is not to be granted, the PSO sends a request denial to user 310 (step 612).

Note that permission table 305 contains an entry for each user. This entry contains a number of fields indicating various permissions. The entry also stores the  
25 signed timestamped permission requests associated with the permissions that have been granted for each user. For example, a given entry for user 310 may include a collection of unique string identifying the user's permissions as well as the signed permission requests associated with the user.

**Process of Validating a Permission**

Throughout the trade creation, amendment and settlement process, the actors in the system including users 310 and 318, security officers 312, 314 and 316, and settlement clerks 311 and 319 require validation of the permissions of fellow actors with whom they are interacting within the system. In the present invention, the actors can append their relevant permissions to a trade record to validate their authorization to perform trading functions. Actors can request a timestamped permission record to document this authorization from CX 200. The status of permissions 340, 341, 350 and 351 can also be confirmed through a query of permission table 305. A query of the permission table may consist of a credential 330-334 and a permission string. The response to a permission query includes the credential, all relevant signed permission requests and a timestamp signed by CX 200.

**Process of Facilitating a Trade**

FIG. 7 is a flow chart illustrating the process of facilitating a trade in accordance with an embodiment of the present invention. This process starts when a user 310 creates and digitally signs a quote request, and sends the quote request to CX 200 (step 702). Note that this quote request can include a list of banks to engage.

Also note that the term "digitally signing" refers to the process of encrypting the computed hash value of a message with a private key belonging to a first entity to generate a "digital signature". Other entities can then verify that the message was signed by the private key belonging to the first entity by decrypting the signature with the public key belonging to the first entity and comparing the result to the computed hash of the message that the signature was attached to.

Upon receiving the quote request, CX 200 looks up the trading permission for user 310 in permission table 305. If the entry in permission table 305 is null (empty), CX 200 rejects the quote request. Otherwise, CX 200 appends a timestamped signed trading permission for user 310 to a trade record containing the quote request (step 704). CX 200 then sends the trade record to the specified bank users (step 706).

Each bank user 318 who receives the trade record checks the signature on the quote request to validate the identity of user 310, and also checks permission information in the trade record to verify that user 310 has permission to perform the trade (step 708) and that the permission was granted by authorized exchange security officers.

If the identity and permission are valid, each interested bank user 318 adds a price quote to the trade record, signs the appropriate fields (as described with reference to FIG. 9) of the trade record, appends the signature, and returns the trade record to CX 200 (step 710).

Next, CX 200 receives trade records with quotes from interested bank users (step 712). CX 200 then performs checks on the quotes and retrieves trading permissions for each interested bank user from permission table 305. If these trading permissions are not null, CX 200 appends the permissions to the trade record (step 714).

When all quotes have been received and the auction time expires, CX 200 returns a compiled quote record along with the augmented trade record to user 310 (step 716). Note that although the present example is presented in the context of a reverse auction, the present invention can generally be applied to trading and settling systems that use any type of pricing mechanism, and is not limited to reverse auctions.

Next, user 310 examines all of the quotes in the compiled quote record, and selects one for execution. If a quote is selected, user 310 tests the signature and permissions of the quote. If these are valid, user 310 signs the portion of the trade record with the selected quote, and returns the trade record to CX 200 (step 718).

Upon receiving the trade record, if no bank user has sent a cancellation prior to receipt of the user selection, and if the decision time has not expired for user 310, CX 200 records the trade in database 301. Upon successful commit, CX 200 sends the appropriate subset of the trade to the winning bank user, and informs all other bank users and user 310 of success or failure (step 720).

Next, bank user 310 sends the trade record to settlement clerk 311 within the same organization 302 to settle the trade (step 722).

**Process of Settling a Trade**

FIG. 8 is a flow chart illustrating the process of settling a trade in accordance with an embodiment of the present invention. The process starts when settlement clerk 311 augments the trade record with allocations of funds and physical settlement instructions. Settlement clerk 311 then signs the related fields of the trade record (step 802). Note that if the settlement instructions are default (standing) instructions, settlement clerk 311 may not have to append additional settlement instructions to the trade record. Settlement clerk 311 also sends payment instructions to funds transfer agent 220.

Next, for each additional approval required in the approval policy for organization 302 a digital signature is requested from the appropriate actors and recorded within the trade record, and the trade record is then returned to CX 200 (step 803).

Upon receiving the trade record, CX 200 looks up the settlement permission for settlement clerk 311. If this permission is not null, CX 200 adds a timestamped record of the permission to the trade record (step 804). CX 200 then commits the trade record to database 301 (step 806), and sends the trade record to bank settlement clerk 319 (step 808).

Upon receiving the trade record, bank settlement clerk 319 checks the signatures and settlement permissions of settlement clerk 311, and possibly checks other signatures and permissions in the trade record. If all are valid, settlement clerk 319 sends instructions to funds transfer agent 221 to complete the trade (step 810). Note in one embodiment of the present invention, bank settlement clerk 319 can determine if there are enough signatures by performing a query CX 200 to retrieve a signed policy record.

**Trade Record Structure**

FIG. 9 illustrates the structure portions of a trade record 900 in accordance with an embodiment of the present invention to trade Spot Foreign Currency Exchange (FX). Trade record 900 includes a number of fields, some of which are  
5 illustrated in FIG. 9.

These fields include trade ID 903 and amend trade ID 905. These fields are used in the amendment process to link which trade record amends which other one. Note that amend trade ID 905 is null for an original trade that has no amendments. In one embodiment of the present invention, the system creates an amending trade in the  
10 database or communicates one that has the same amend trade ID 905 field as a trade record that is already in the database. The system also refuses to make further changes to a trade record that has an amending trade record whose amend trade ID 905 field points to it. If a new amendment is made to a previously amended trade, the amend trade ID 905 field of the new amendment reflects the value of the trade ID 903  
15 field of the previously amended trade. In one embodiment of the present invention, the trade record may also contain an original trade ID field 907. For new trades, this field 907 stores the same value as trade ID field 905. For amended trades, this field 907 stores the trade ID of the original trade that the amendment modifies. If the amendment modifies a previous amendment, this field 907 should reference the  
20 original trade ID. This field can be used to link related trades and amendments to an provide an efficient index for trade queries.

Status field 901 indicates a status of the trade record. For example, the trade record may have a status of "pending," "valid," "old" or "cancelled pending."  
"Pending" indicates that the record has not yet been agreed upon between the two  
25 parties to the trade. "Valid" indicates that the trade record has been agreed to between the parties is currently in force. "Old" indicates that the trade record has been superceded by an amended trade record. "Cancelled pending" indicates that the trade record was never agreed to, and was superceded by another amended trade record. Note that status field 901 is not signed because it is computable from the other trades  
30 and is added by CX 200 as a convenience for reporting.

Trade date 902 identifies the date the trade took place, and value date 904 which identifies the date the currency is to be exchanged.

Currency 1 (CCY1) identifier 906 identifies a first currency involved in the trade (such as US Dollars). CCY1 amount 908 specifies an amount of the first  
5 currency involved in the trade. CCY2 identifier 910 identifies a second currency involved in the trade (such as Japanese Yen). CCY2 amount 912 specifies an amount of the second currency involved in the trade. Conversion rate 914 specifies a conversion rate between the first currency and the second currency.

CCY1 organization 916 identifies a first organization involved in the trade,  
10 and CCY1 subsidiary 918 identifies a specific subsidiary of the first organization that is involved in the trade. CCY2 organization 920 identifies a second organization involved in the trade, and CCY2 subsidiary 922 identifies a specific subsidiary of the second organization that is involved in the trade.

CCY1 account 924 identifies and account for the first organization, and CCY1  
15 custodian 926 identifies an institution (bank) maintaining the account for the first organization. CCY2 account 928 identifies and account for the second organization, and CCY2 custodian 930 identifies an institution maintaining the account for the second organization.

There are also trading, settlement and settlement approval signatures for  
20 currency one, 932, 934 and 935, as well as trading, settlement and settlement approval signatures for currency two, 936, 938 and 939.

Note that certain portions of trade record 900 are signed by a user, such as front office trader 310, and other portions are signed by a settlement clerk, such as settlement clerk 311. In particular, front office trader 310 signs portions of trade  
25 record 900 that include trade parameters. Settlement clerk 311 (and a settlement approver) signs these as well as the portions of trade record 900 that contain settlement instructions, such as account identifiers. (The "1" values in FIG. 9 indicate which portions of the trade record are signed by respective entities, the "-" values indicate portions which are not signed, and the "S" values indicate the respective  
30 digital signatures.)

### **Policy Approval Record Structure**

Policy Approval Records are used as a control mechanism for ensuring that the proper authorization checks are performed by the system. The policy approval records are made up of authorization rules and a set of associated digital signatures that validate those rules. An initial policy approval record may be bootstrapped into the system. This initial record should ideally impose a base restriction that all policy approval records must be signed by a minimum of two security officers and the policy itself should be signed by the two original exchange security officers (the exchange PSO and CSO). This requirement prevents a single individual from perpetrating fraud in the system by relaxing authorization safeguards.

From this base policy, additional policy approval records can then be defined to further configure the system's permission handling functions. For instance, policies can be defined to enforce things such as the number of signatures required to approve a trade or an amendment. These policies are confirmed against all actions performed on the system to ensure that the requisite validations have been met.

### **Process of Establishing a Policy for Approvals**

FIG. 10 is a flow chart illustrating the process of establishing a policy for approvals relating to trades and amendments in accordance with an embodiment of the present invention. A first security officer for an organization (such as for example security officer 312 or 316) first sets the new policy or amends an existing policy to create a new policy (step 1002), and then signs the new policy (step 1004). In order to conform to the bootstrapped system policy, which dictates dual signatures for new policies, the new policy is then communicated to a second security officer within the same organization (step 1006). This second security officer examines the new policy (step 1008). If the new policy properly conforms to established rules for the organization, the second security officer signs the new policy and stores it in database 301, which causes the new policy to come into force (step 1010). Note that by requiring at least two security officers within an organization to approve policy

changes, a single security officer is unable to unilaterally change the organization's security policy.

For instance, a Permission Security Officer (PSO) may propose a policy that requires two settlement clerks to sign and approve a trade settlement instruction. The PSO generates a policy approval record defining that rule set and signs the record. The PSO must then get a second security officer to agree to sign the rule set in order to validate the policy in the system. Once the policy has been defined and validated, the system will impose the new dual signature requirement on any new trade settlement instructions.

10

### Amendment Record

FIG. 11 illustrates the structure of an amendment record 1100 in accordance with an embodiment of the present invention. Amendment record 1100 contains a number of trade records, such as trade record 900. Each of these trade records has an associated status indicator, which indicates the status of the trade record. When a trade record has not been approved by both sides of the transaction, the status of the record is "pending." When a trade record has been agreed upon by both parties, its status becomes "valid." If a trade record is superseded by a subsequent approved trade record, the status of the trade record becomes "old." If a pending trade record is never approved, but is superseded by a subsequent trade record, its status becomes "cancelled pending."

Note that the status field can be derived from the signatures within the trade record. However, when an entity wishes to check the status of a trade record, the entity does not rely on the derived status filed, but instead checks the underlying signatures in the trade record to verify that the trade record has been properly approved.

25

### Process of Amending a Trade

FIG. 12 is a flow chart illustrating the process of amending a trade in accordance with an embodiment of the present invention. This process starts when a

30



user 310, or someone else authorized to amend trades, creates and digitally signs a trade amendment request, and sends the trade amendment request to CX 200 (step 1202).

Upon receiving the trade amendment request, CX 200 looks up an amendment  
5 permission for user 310 in permission table 305. If the entry in permission table 305 is null (empty), CX 200 rejects the trade amendment request. Otherwise, CX 200 appends the amendment permission for user 310 to an amendment record containing the trade amendment request (step 1204). CX 200 then sends the trade amendment record to the bank user 318 or someone else authorized to approve trade amendments  
10 (step 1206). Note that there may exist different amendment permissions for different types of amendments.

Bank user 318 checks the signature on the trade amendment request to validate the identity of user 310, and also checks permission information in the amendment record to verify that user 310 has permission to approve the amendment (step 1208).

15 If the identity and permission are valid, bank user 318 provides counter-terms if desired, signs the trade record, and returns the trade record to CX 200 (step 1210). Note that bank user 318 may also decide to accept the amendment without counter-terms.

Next, CX 200 receives the amendment record from bank user 318 (step 1212).  
20 CX 200 then performs checks on the trade amendment and retrieves amending permissions for bank user 318 from permission table 305. If these amending permissions are not null, CX 200 appends the permissions to the amendment record (step 1214).

Next, user 310 examines the trade amendment reply from bank user 318. If  
25 the reply is acceptable, user 310 validates the signature and permissions of the amendment. If these are valid, user 310 signs the amendment record and returns the amendment record to CX 200 (step 1218).

Upon receiving the amendment record, CX 200 records the acceptance or cancellation of the amendment in database 301. CX 200 also checks the signatures  
30 and if all are valid and respective organization policies are met, updates the status

field for the amended and amendment trades to reflect the acceptance or cancellation.

Upon successful commit, CX 200 sends the amendment record to bank user 318 (step 1220).

5 Note that in general any type of distributed commit protocol can be used to allow customers and banks to agree on trade amendments.

The foregoing descriptions of embodiments of the invention have been presented for purposes of illustration and description only. They are not intended to be exhaustive or to limit the present invention to the forms disclosed. Accordingly, many modifications and variations will be apparent to practitioners skilled in the art.

10 Additionally, the above disclosure is not intended to limit the present invention. The scope of the present invention is defined by the appended claims.

**What Is Claimed Is:**

1. A method for using digital signatures to validate an amendment to a financial transaction, comprising:
  - 5 receiving a request to make the amendment to the financial transaction, wherein the financial transaction was previously agreed upon between a first party and a second party, wherein the request is received from a first representative of the first party and includes a suggested change to at least one term of the financial transaction;
  - 10 validating that the first representative of the first party digitally signed the request by using a public key of the first representative to verify that the request was signed by a corresponding private key belonging to the first representative;  
if the validation establishes that the first representative signed the request and if the second party desires to agree to the request,
  - 15 allowing a second representative of the second party to confirm the request by digitally signing the request with a private key belonging to the second representative, and  
returning the confirmed request to the first party.
- 20 2. The method of claim 1, further comprising, prior to confirming request, validating that the first representative has permission to agree to the amendment by verifying that permission information for the first representative is digitally signed by a trusted entity.
- 25 3. The method of claim 1, further comprising, if the validation establishes that the first representative signed the request, and if the second party does not agree to the request, but instead desires to propose counter-terms, allowing the second party to propose counter-terms by:
  - creating a responding request including a responding amendment with the  
30 counter-terms;

26

allowing the second representative of the second party to digitally sign the responding request with a private key belonging to the second representative; and sending the signed responding request to the first party.

- 5           4.     The method of claim 3, further comprising:  
              validating that the second representative of the second party digitally signed the responding request by using a public key of the second representative to verify that the responding request was signed by a corresponding private key belonging to the second representative; and  
10           if the validation establishes that the second representative signed the responding request, and if the first party desires to agree to the responding request, allowing the first representative of the first party to confirm the responding request by digitally signing the responding request with a private key belonging to the first representative, and  
15           returning the confirmed responding request to the second party.

5.     The method of claim 4, further comprising, prior to allowing the first representative to confirm the responding request, validating that the second representative has permission to agree to the amendment by verifying that permission  
20           information for the second representative is digitally signed by a trusted entity.

6.     The method of claim 1, further comprising recording the request and any response to the request in a database.

- 25           7.     The method of claim 1, further comprising validating an identity of the first party by using a public key of a certification authority to verify that a certificate containing the public key of the first party was signed by a corresponding private key belonging to the certification authority;  
              wherein the signing by the certification authority indicates that the  
30           certification authority has verified the identity of the first party.

8. The method of claim 1,  
wherein receiving the request from the first party involves receiving the  
request from a trade facilitator that previously received the request from the first  
5 party; and

wherein returning the confirmed request to the first party involves forwarding  
the confirmed request to the first party through the trade facilitator.

9. The method of claim 1, wherein prior to receiving the request to make  
10 the amendment, the method further comprises, allowing the first representative of the  
first party to obtain permission to amend the financial transaction by:

sending a request for permission to a first security officer associated with the  
first party; and

allowing the first security officer to digitally sign a permission record to  
15 indicate the first representative has permission to agree to the amendment.

10. The method of claim 1, wherein the financial transaction involves  
foreign exchange, and wherein a trade record for the financial transaction includes:

a trade identifier;  
20 an amend trade identifier;  
a trade date;  
an identifier for a first currency;  
a first currency amount;  
an identifier for a first organization providing the first currency;  
25 an identifier for a second currency;  
a second currency amount; and  
an identifier for a second organization providing the second currency.

11. A computer-readable storage medium storing instructions that when  
30 executed by a computer cause the computer to perform a method for using digital

signatures to validate an amendment to a financial transaction, the method comprising:

- receiving a request to make the amendment to the financial transaction, wherein the financial transaction was previously agreed upon between a first party and a second party, wherein the request is received from a first representative of the first party and includes a suggested change to at least one term of the financial transaction;
- validating that the first representative of the first party digitally signed the request by using a public key of the first to verify that the request was signed by a corresponding private key belonging to the first representative;
- if the validation establishes that the first representative signed the request and if the second party desires to agree to the request,
  - allowing a second representative of the second party to confirm the request by digitally signing the request with a private key belonging to the second representative, and
  - returning the confirmed request to the first party.

12. The computer-readable storage medium of claim 11, wherein prior to confirming request the method further comprises, validating that the first representative has permission to agree to the amendment by verifying that permission information for the first representative is digitally signed by a trusted entity.

13. The computer-readable storage medium of claim 11, wherein if the validation establishes that the first representative signed the request, and if the second party does not agree to the request, but instead desires to propose counter-terms, the method further comprises allowing the second party to propose counter-terms by:

- creating a responding request including a responding amendment with the counter-terms;

- allowing the second representative of the second party to digitally sign the responding request with a private key belonging to the second representative; and

sending the signed responding request to the first party.

14. The computer-readable storage medium of claim 13, wherein the method further comprises:

- 5       validating that the second representative of the second party digitally signed the responding request by using a public key of the second representative to verify that the responding request was signed by a corresponding private key belonging to the second representative; and
- if the validation establishes that the second representative signed the
- 10    responding request, and if the first party desires to agree to the responding request,
- allowing the first representative of the first party to confirm the responding request by digitally signing the responding request with a private key belonging to the first representative, and
- returning the confirmed responding request to the second party.

15

15. The computer-readable storage medium of claim 14, wherein prior to allowing the first representative to confirm the responding request, the method further comprises validating that the second representative has permission to agree to the amendment by verifying that permission information for the second representative is
- 20    digitally signed by a trusted entity.

25

16. The computer-readable storage medium of claim 11, wherein the method further comprises recording the request and any response to the request in a database.
17. The computer-readable storage medium of claim 11, wherein the method further comprises validating an identity of the first party by using a public key of a certification authority to verify that a certificate containing the public key of the first party was signed by a corresponding private key belonging to the certification
- 30    authority;

30

wherein the signing by the certification authority indicates that the certification authority has verified the identity of the first party.

18. The computer-readable storage medium of claim 11,  
5 wherein receiving the request from the first party involves receiving the request from a trade facilitator that previously received the request from the first party; and

wherein returning the confirmed request to the first party involves forwarding the confirmed request to the first party through the trade facilitator.

10

19. The computer-readable storage medium of claim 11, wherein prior to receiving the request to make the amendment, the method further comprises allowing the first representative of the first party to obtain permission to amend the financial transaction by:

15 sending a request for permission to a first security officer associated with the first party; and

allowing the first security officer to digitally sign a permission record to indicate the first representative has permission to agree to the amendment.

20 20. The computer-readable storage medium of claim 11, wherein the financial transaction involves foreign exchange, and wherein a trade record for the financial transaction includes:

a trade identifier;

an amend trade identifier;

25 a trade date;

an identifier for a first currency;

a first currency amount;

an identifier for a first organization providing the first currency;

an identifier for a second currency;

30 a second currency amount; and



an identifier for a second organization providing the second currency.

21. An apparatus that uses digital signatures to validate an amendment to a financial transaction, comprising:

- 5 a receiving mechanism that is configured to receive a request to make the amendment to the financial transaction, wherein the financial transaction was previously agreed upon between a first party and a second party, wherein the request is received from a first representative of the first party and includes a suggested change to at least one term of the financial transaction;
- 10 a validation mechanism that is configured to validate that the first representative of the first party digitally signed the request by using a public key of the first representative to verify that the request was signed by a corresponding private key belonging to the first representative;
- an agreement mechanism, wherein if the validation establishes that the first
- 15 representative signed the request, and if the second party desires to agree to the request, the agreement mechanism is configured to,
- allow a second representative of the second party to confirm the request by digitally signing the request with a private key belonging to the second representative, and to
- 20 return the confirmed request to the first party.

22. The apparatus of claim 21, further comprising, wherein prior to confirming request, the validation mechanism is configured to validate that the first representative has permission to agree to the amendment by verifying that permission

25 information for the first representative is digitally signed by a trusted entity.

23. The apparatus of claim 21, wherein if the validation establishes that the first representative signed the request, and if the second party does not agree to the request, but instead desires to propose counter-terms, the agreement mechanism is

30 configured to:

32

create a responding request including a responding amendment with the counter-terms;

allow the second representative of the second party to digitally sign the responding request with a private key belonging to the second representative; and to  
5 send the signed responding request to the first party.

24. The apparatus of claim 23, further comprising:

a second validation mechanism associated with the first party;

wherein the second validation mechanism is configured to validate that the  
10 second representative of the second party digitally signed the responding request by using a public key of the second representative to verify that the responding request was signed by a corresponding private key belonging to the second representative; and

a second agreement mechanism associated with the first party;

15 wherein if the validation establishes that the second representative signed the responding request, and if the first party desires to agree to the responding request, the second agreement mechanism is configured to,

allow the first representative of the first party to confirm the responding request by digitally signing the responding request with a  
20 private key belonging to the first representative, and to return the confirmed responding request to the second party.

25. The apparatus of claim 24, wherein prior to allowing the first representative to confirm the responding request, the second validation mechanism is  
25 configured to validate that the second representative has permission to agree to the amendment by verifying that permission information for the second representative is digitally signed by a trusted entity.

26. The apparatus of claim 21, further comprising an archiving mechanism  
30 that is configured to record the request and any response to the request in a database.

27. The apparatus of claim 21, wherein the validation mechanism is configured to validate an identity of the first party by using a public key of a certification authority to verify that a certificate containing the public key of the first party was signed by a corresponding private key belonging to the certification authority;

wherein the signing by the certification authority indicates that the certification authority has verified the identity of the first party.

28. The apparatus of claim 21, wherein the receiving mechanism is configured to receive the request from a trade facilitator that previously received the request from the first party; and wherein the agreement mechanism is configured to return the confirmed request to the first party by forwarding the confirmed request to the first party through the trade facilitator.

29. The apparatus of claim 21, further comprising a permission obtaining mechanism, wherein prior to receiving the request to make the amendment, the permission obtaining mechanism is configured to:

send a request for permission to a first security officer associated with the first party; and to allow the first security officer to digitally sign a permission record to indicate the first representative has permission to agree to the amendment.

30. The apparatus of claim 21, wherein the financial transaction involves foreign exchange, and wherein a trade record for the financial transaction includes:

- a trade identifier;
- an amend trade identifier;
- a trade date;
- an identifier for a first currency;

34

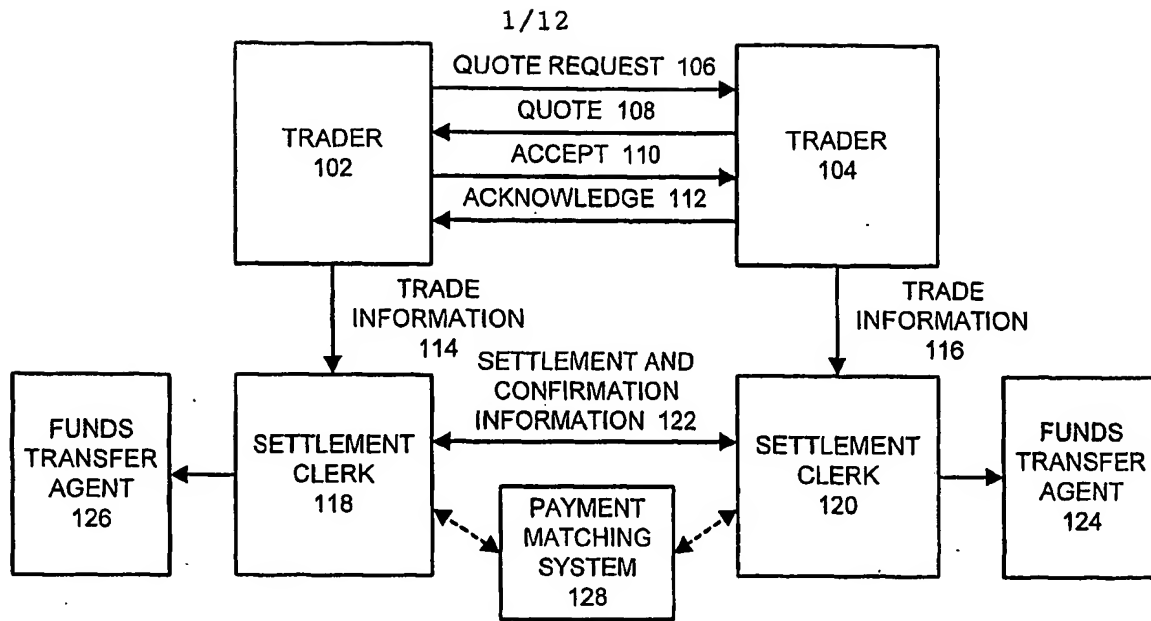
a first currency amount;

an identifier for a first organization providing the first currency;

an identifier for a second currency;

a second currency amount; and

5 an identifier for a second organization providing the second currency.



**FIG. 1**  
**(PRIOR ART)**

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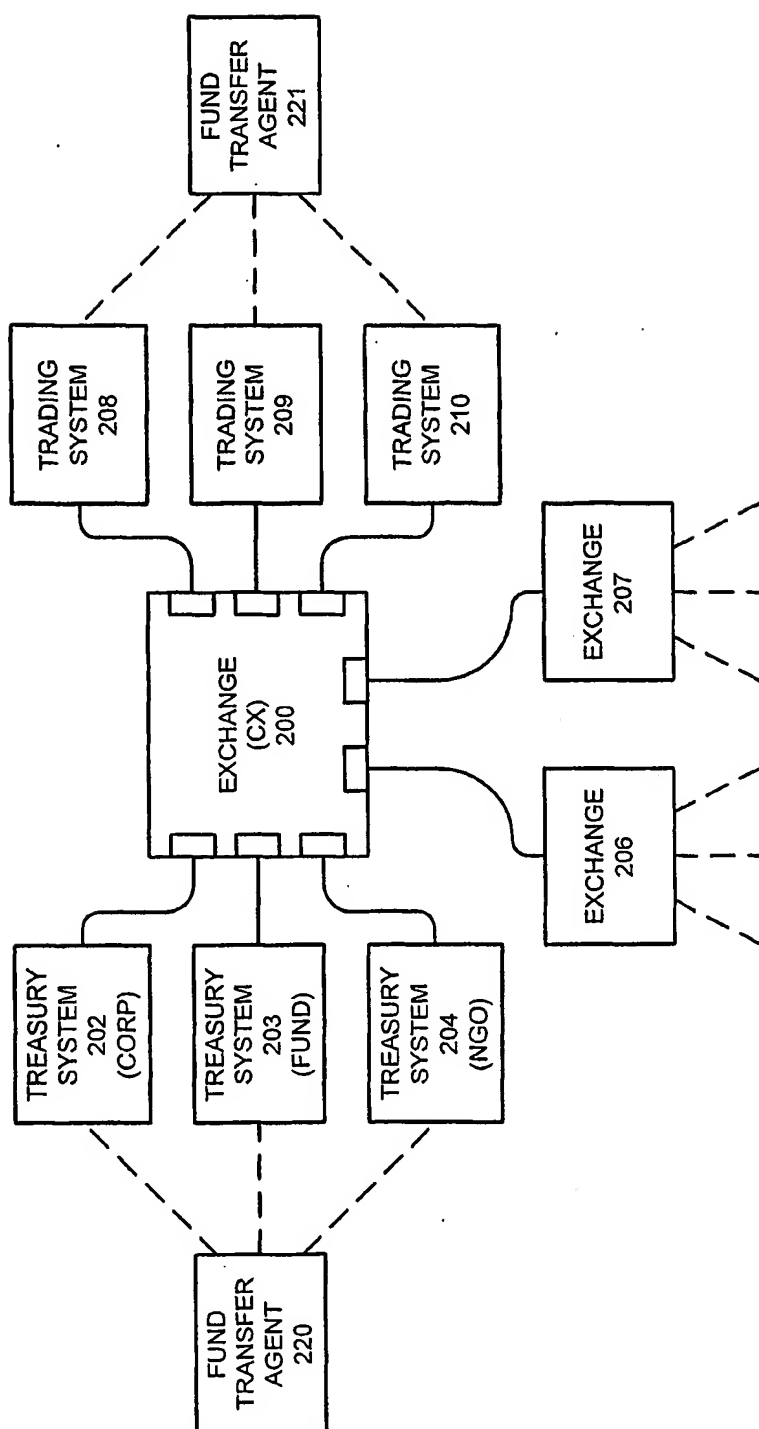


FIG. 2

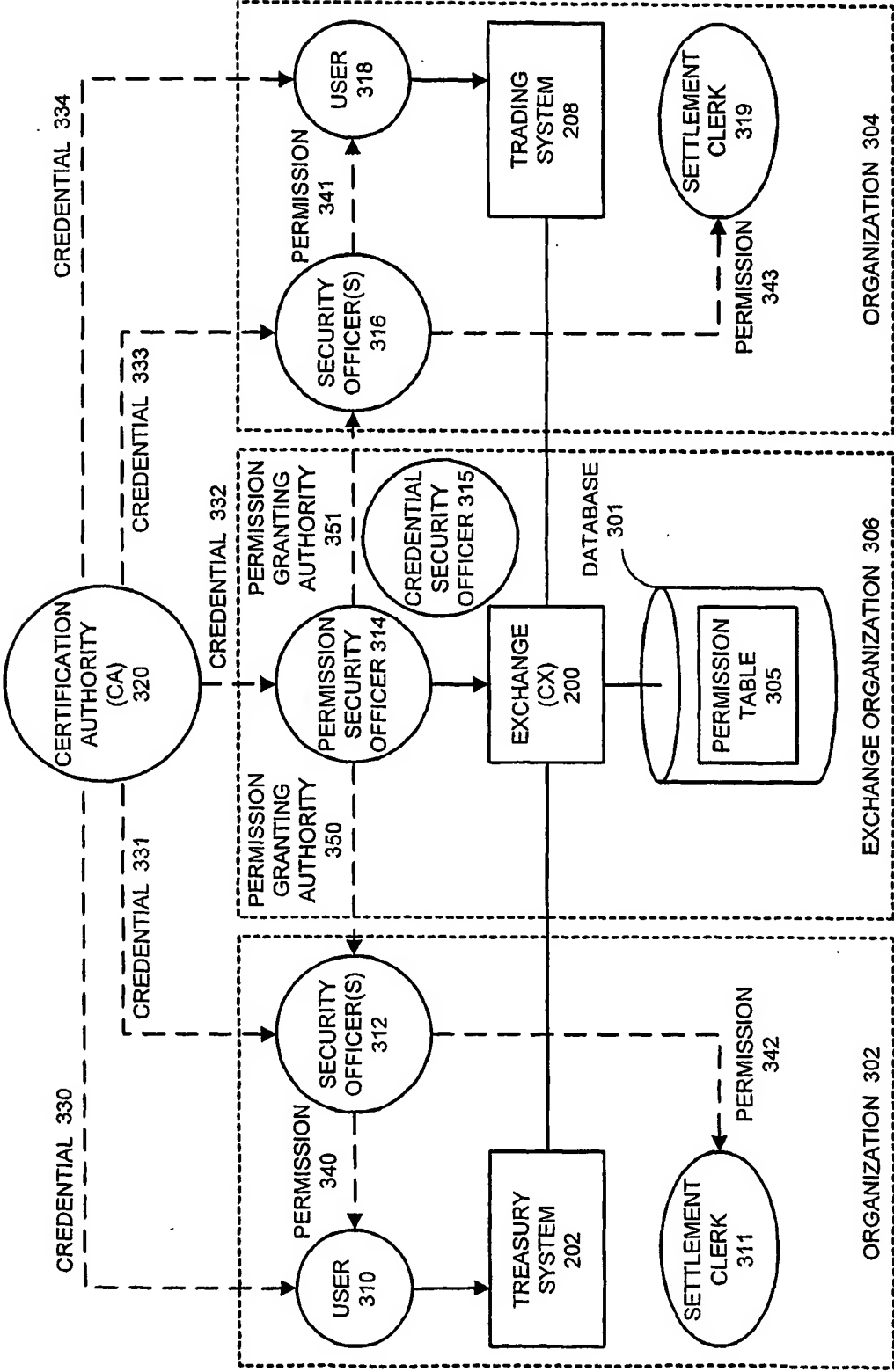


FIG. 3

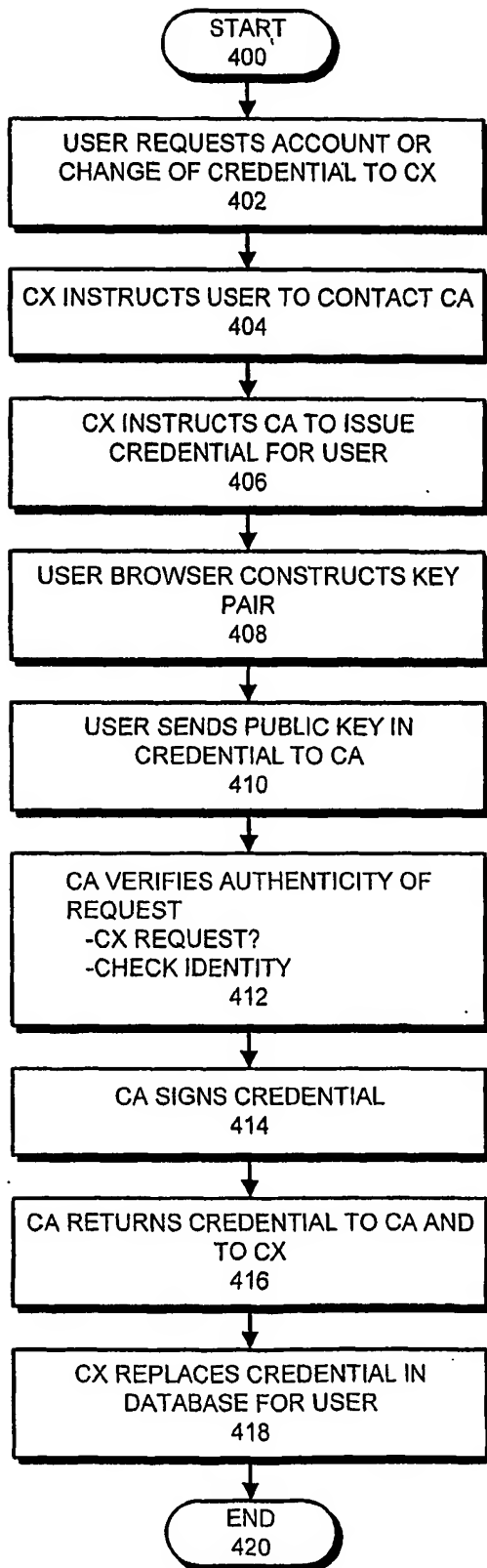


FIG. 4

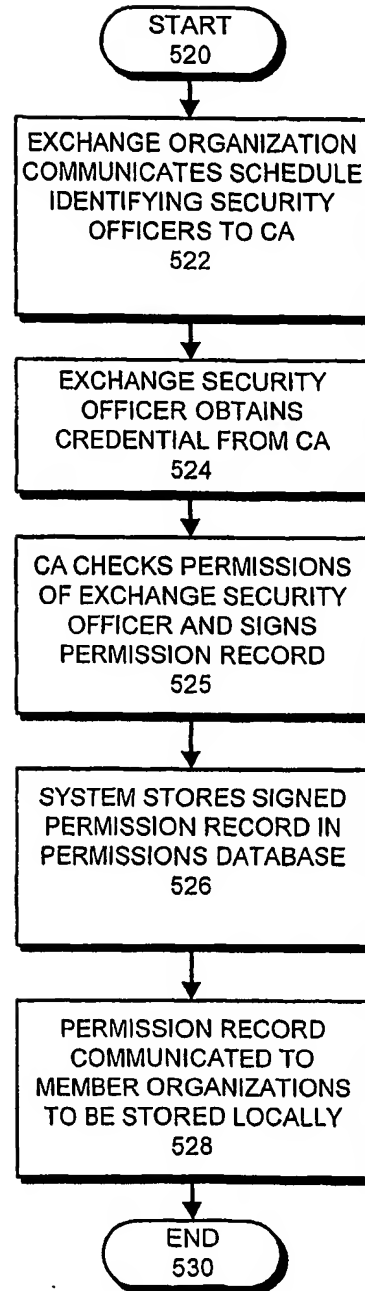


FIG. 5A



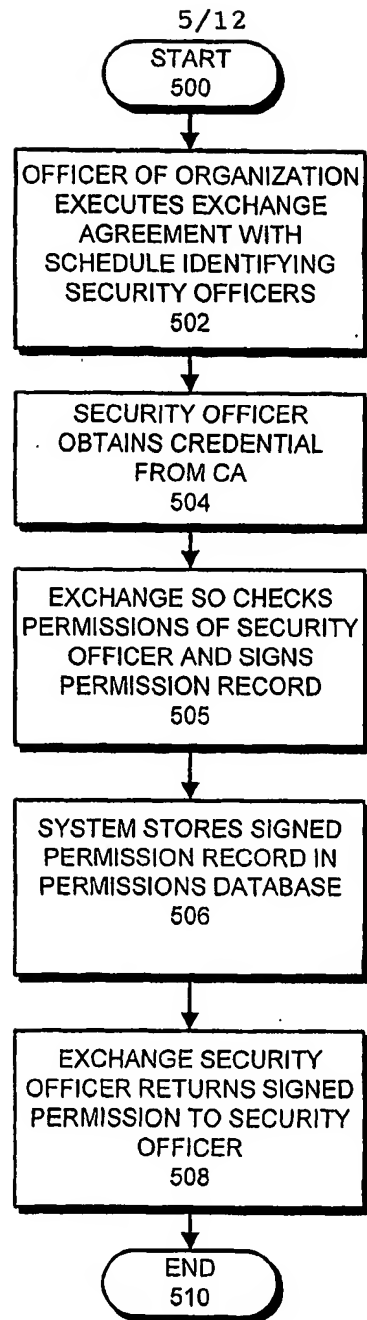


FIG. 5B

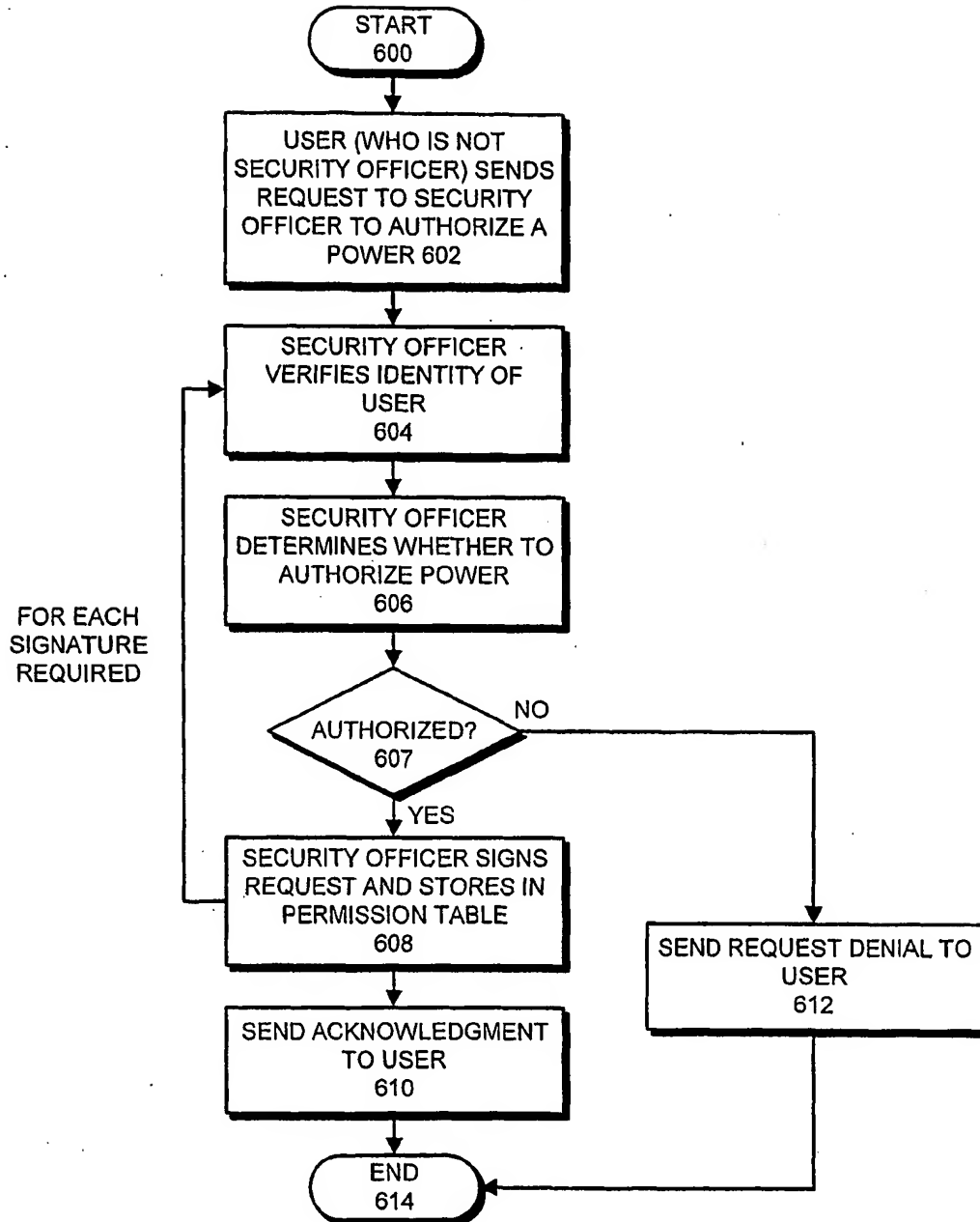


FIG. 6

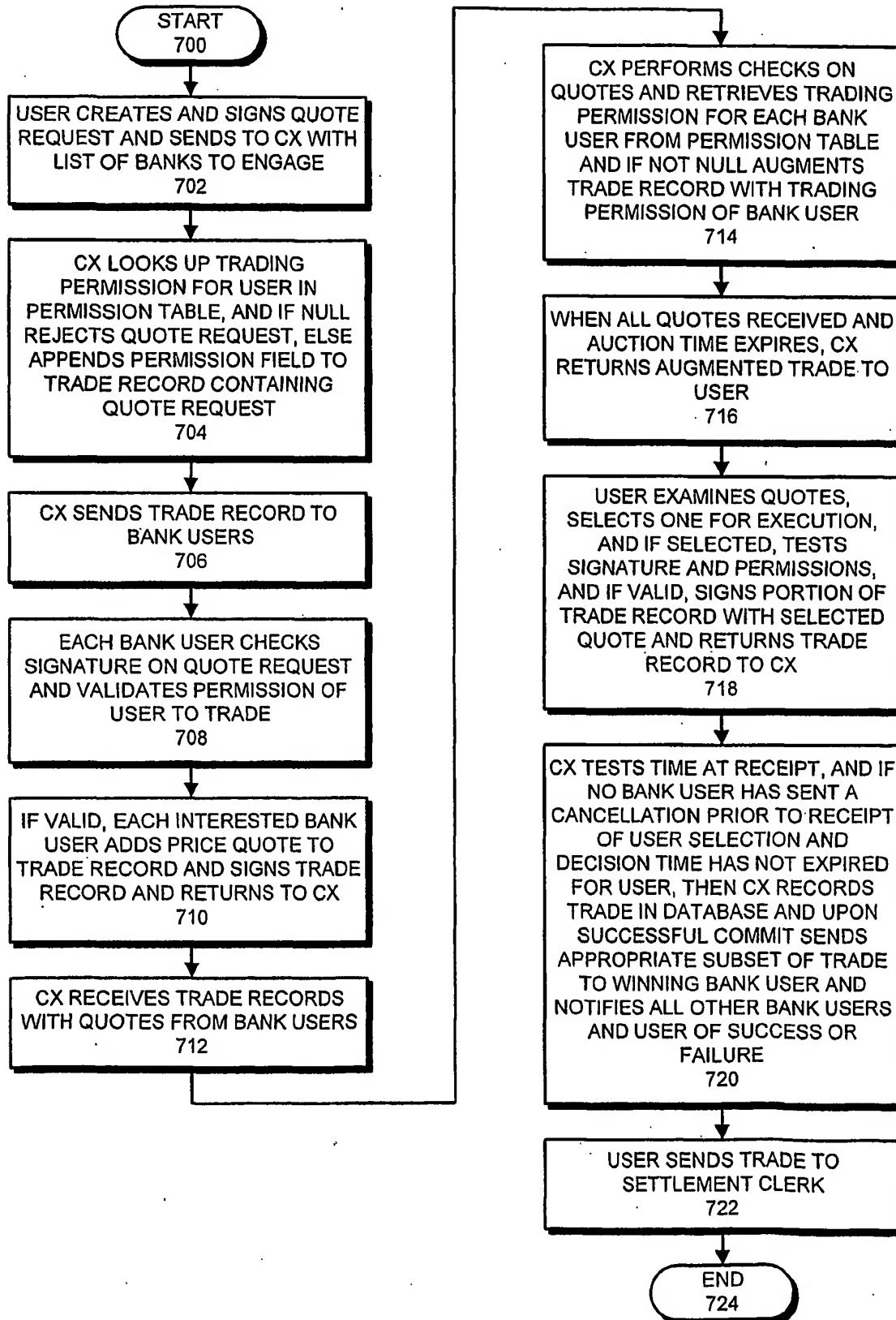
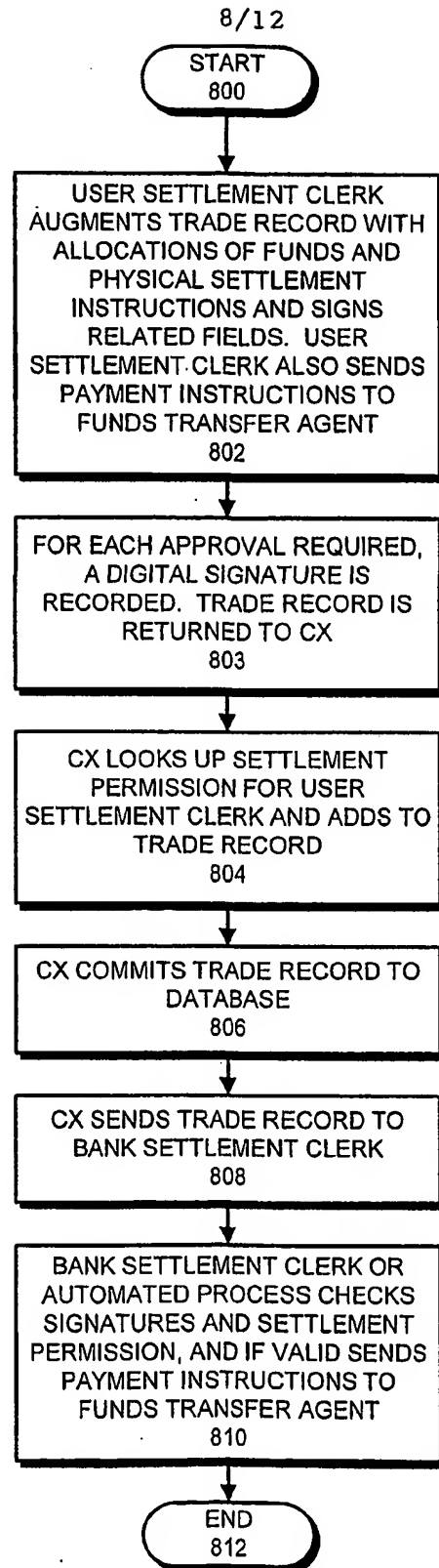


FIG. 7

**FIG. 8**

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FRONT OFFICE TRADER(S) 310	SETTLE- MENT CLERK(S) 311	FRONT OFFICE TRADER(S) 318	SETTLE- MENT CLERK(S) 319	TRADE RECORD 900
1	1	1	1	TRADE ID 903
1	1	1	1	AMEND TRADE ID 905
1	1	1	1	ORIGINAL TRADE ID 907
-	-	-	-	STATUS 901
1	1	1	1	TRADE DATE 902
1	1	1	1	VALUE DATE 904
1	1	1	1	CCY1 IDENTIFIER 906
1	1	1	1	CCY1 AMOUNT 908
1	1	1	1	CCY2 IDENTIFIER 910
1	1	1	1	CCY2 AMOUNT 912
-	-	-	-	CONVERSION RATE 914
-	1	-	-	CCY1 ORGANIZATION 916
-	1	-	-	CCY1 SUBSIDIARY 918
-	-	-	1	CCY2 ORGANIZATION 920
-	-	-	1	CCY2 SUBSIDIARY 922
-	1	-	-	CCY1 ACCOUNT 924
-	1	-	-	CCY1 CUSTODIAN 926
-	-	-	1	CCY2 ACCOUNT 928
-	-	-	1	CCY2 CUSTODIAN 930
S				CCY1 TRADE SIGNATURE 932
	S			CCY1 SETTLEMENT SIGNATURE 934
	S			CCY1 PAYMENT INSTRUCTION APPROVAL 935
		S		CCY2 TRADE SIGNATURE 936
			S	CCY2 SETTLEMENT SIGNATURE 938
			S	CCY2 PAYMENT INSTRUCTION APPROVAL 939

FIG. 9

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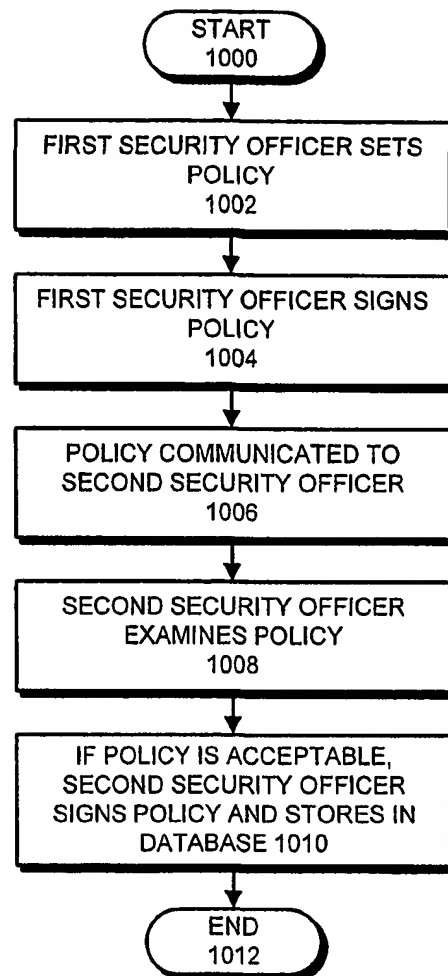


FIG. 10

STATUS		SIGNATURES								AMENDMENT RECORD 1100	TRADE RECORD 900
PENDING		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
VALID		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
OLD		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
CANCELLED PENDING		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
OLD		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
• • •		• • •									

FIG. 11

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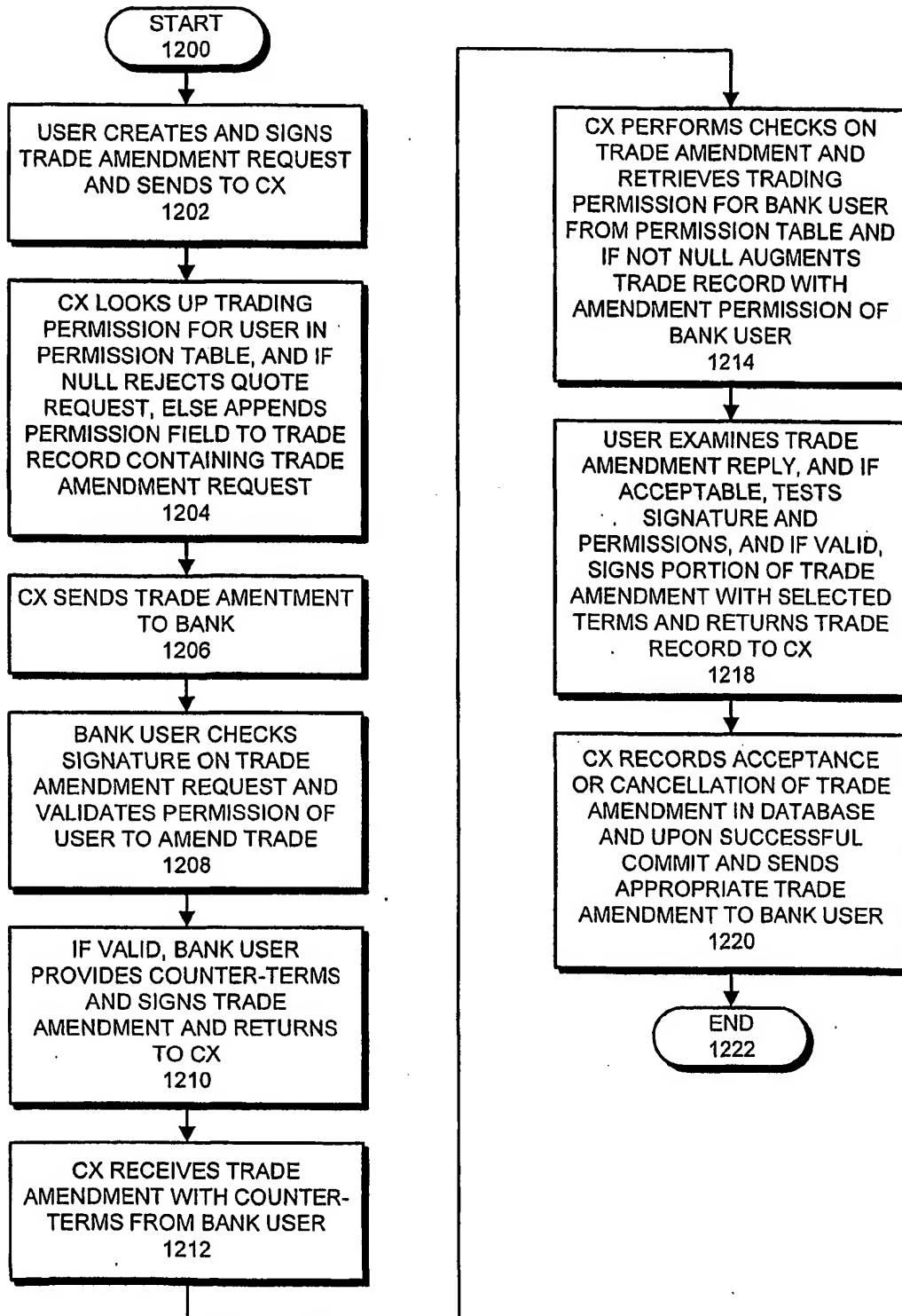


FIG. 12